NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

(Acre)

CODE 590

DEFINITION

Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments.

PURPOSES

- To budget and supply nutrients for plant production.
- To properly utilize manure or organic by-products as a plant nutrient source.
- To minimize agricultural nonpoint source pollution of surface and ground water resources.
- To protect air quality by reducing nitrogen emissions (ammonia and NO_x compounds) and the formation of atmospheric particulates.
- To maintain or improve the physical, chemical and biological condition of soil.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where plant nutrients and soil amendments are applied.

CRITERIA

General Criteria Applicable to All Purposes

A nutrient budget for nitrogen (N), phosphorus (P), and potassium (K) shall be developed that considers all potential sources of nutrients including, but not limited to animal manure and organic by-products, waste water, inorganic/commercial fertilizer, crop residues, legume credits, and irrigation water.

Realistic yield goals shall be established using guidance outlined in **Oklahoma State University Extension (OSU) Fact Sheet F-2225, OSU Soil Test Interpretations**. A realistic yield goal is generally the average yield over the last 5 years plus 20%. Rates of nutrient application established by OSU will be the basis for nutrient recommendations.

For new crops or varieties, industry yield recommendations may be used until documented yield information is available.

Plans for nutrient management shall specify the form, source, amount, timing and method of application for each field to achieve realistic production goals and minimize the loss of nutrients to erosion, runoff, volatilization, and leaching.

Lime shall be applied, as needed, to adjust soil pH when below a crop's tolerance except as noted for the establishment of permanent grasses in **Tables 4 and 5.** Crop pH preferences are listed in **Table 5** and Liming requirements are listed in **Table 4**.

Plans for nutrient management that are elements of a more comprehensive conservation plan shall recognize other requirements of the plan and be compatible with those requirements.

Nutrient applications associated with irrigation systems shall be applied in accordance with the requirements of Oklahoma NRCS Irrigation Water Management (449) standard and according to the NRCS National Engineering Handbook, Part 652, Irrigation Guide.

Using effluent water for irrigating crops and grasses can increase salt concentrations in the soil creating a negative impact on plant growth. Oklahoma Technical Note Agronomy OK-17 contains guidance for irrigating with effluent water.

SOIL AND TISSUE SAMPLING LABORATORY ANALYSIS (TESTING)

A current soil test will be no older than three (3) years unless otherwise required by federal, state or local laws. Nutrient planning shall be based on current soil or tissue (where used as a supplement) test results developed in accordance with OSU guidance.

Soil samples shall be taken at least once every three (3) years for analysis or more often if the crop rotation changes.

Soil salinity testing to monitor salt accumulation in the soil is recommended when large quantities of manure or organic by-products are being applied annually. This salinity analysis can be done in conjunction with routine soil testing every 3 years.

A soil salinity analysis shall be performed when waste water effluent used for irrigation has been applied on an area for 3 years or more. The area shall be monitored for salinity accumulation annually using a soil salinity analysis as long as effluent is being applied. This analysis should include results for Na, Ca, Mg, K, B, EC, TSS (total soluble salts), Sodium Adsorption Ratio (SAR), Exchangeable Sodium Percentage (ESP), and pH.

Grass plantings done under the Oklahoma NRCS Pasture and Hay Planting (512) or Range Planting (550) standards shall have a current soil analysis for plant available N, P, K and pH. Nitrogen will be assumed to be zero (0) if the test is older than 60 days. **Tables 1, 2, 3, and 4** provide detailed guidance for determining fertilizer and lime requirements for grass establishment.

All grass plantings done under the Oklahoma NRCS Critical Area Planting (342) standard should have a soil analysis performed. In lieu of a current soil test, a fertilizer application of 40 lbs/ac N, 40 lbs/ac P_2O_5, and 40 lbs/ac K_2O will be recommended.

Manure or organic by-products (excluding effluent water) may be used for the establishment of permanent grasses however, application rates and application timing will be determined according to the guidance used for inorganic/commercial fertilizers.

Fertilizer applications for grass establishment should be done in a timely manner that allows the grass to utilize nutrients for quicker establishment, to minimize weed populations, and to avoid loss of fertilizer from the crop zone. When nitrogen is required for grass plantings, the application shall be made between March 1 and June 30 for warm season species and September 1 through November 15 for fall planted cool season species or March 1 through April 30 for spring planted cool season species. Phosphorus and potassium applications may be made at the same dates as above or incorporated at the last tillage for seedbed preparation prior to planting. Lime applications will be incorporated into the soil prior to planting grass.

All soil samples will be collected at the 0 to 6-inch depth. Occasionally, there will be reasons for taking shallower soil samples (1-3 inch depth) for analysis (e.g. potential pH concerns on a no till field).

A minimum of 15 to 20 core samples shall be taken randomly from the field or sample area. The core samples shall be collected and mixed thoroughly in a clean plastic container. Approximately one (1) pint of the mixed core samples will be placed in a bag and sent for testing.

When the soil test for N exceeds the recommended plant requirements (excessive), a representative soil sample will be taken for the subsoil in addition to the 6-inch sample. This sample shall represent the soil layer from 7 to 24 inches in depth. *Subsoil samples will not be required for grass establishment.* The OSU County Extension Service Office is available to assist with the soil testing process. Additional information concerning soil sampling can be found in the **OSU Extension Fact Sheet F-2207, How to Get a Good Soil Sample.**

If a soil test laboratory other than OSU is used, the lab shall use the same phosphorus and potassium extractant (Mehlich-3) as used by the OSU lab and nutrient recommendations will be the same as those used by OSU. The soil testing laboratory shall be a member of the North American Proficiency Testing Program.

Soil testing shall include analysis for any nutrients for which specific information is needed to develop the nutrient management plan (e.g. pH, N, P, and K). Additional information concerning soil testing can be found in the **OSU Extension Fact Sheet F-2225, OSU Soil Test Interpretations and Fact Sheet F-2901, Procedures Used by OSU Soil, Water, and Forage Analytical Laboratory.**

Additional Criteria to Budget and Supply Nutrients for Plant Production

Inorganic/Commercial Nutrient Application Rates

Application rates of inorganic/commercial sources of nutrients shall be based on recommendations that consider current soil test results, realistic yield goals and management capabilities. OSU nutrient recommendations for major crops and grasses are contained in **Tables 1, 2, 3, and 4**.

The following guidance shall also be used when applying inorganic/commercial sources of nutrients:

- **Nitrogen Application** - N application rates shall match the required rates as closely as possible **(Table 1)**.

- **Phosphorus (P_2O_5) Application** - P_2O_5 application rates shall match the required rates as closely as possible **(Table 2)**.
- **Potassium (K_2O) Application** - K_2O application rates shall match the required rates as closely as possible **(Table 3)**.
- **Other Plant Nutrients** - The planned rates of application for secondary and micronutrients shall be consistent with **OSU guidance (OSU Extension Fact Sheet F-2225)**.
- **Available fertilizer blends make it difficult to apply fertilizer to meet specific recommendations. Applications of inorganic/commercial nutrients will be considered adequate when:**
  - ***The applied rate is no more than 10% below or 10 pounds less, whichever is greater, than the recommended application rate***.
  - The applied rate of either N or P_2O_5 does not exceed 50 lbs/ac of the recommended application rate.
- **Starter Fertilizers** - Starter fertilizers containing N, P, and/or K may be applied to row crops to overcome early stress of the root environment such as a cool, wet soil. Starter fertilizers are applied in the row with the seed or banded along side the seed. In general, OSU guidance recommends no more than 30 lbs. of either N or K_2O per acre or in combination for wheat or 7 lbs/ac for corn. No more than 90 lbs. per acre of P_2O_5 will be used in a starter fertilizer. These rates will vary with crop selection and climate conditions. The OSU County Extension Service Office is available for assistance in this area. The amount of starter fertilizer applied will be included in the nutrient budget.
- **Maintenance Fertilizers** - USDA Farm Programs such as the Conservation Reserve Program (CRP) require a periodic maintenance amount of fertilizer to maintain a stand of grass. In these long-term deferment programs the fertilizer maintenance recommendations for N, P, and K are contained in **Tables 1, 2, and 3 on page 15**.

Nutrient Application Timing and Method

Timing and method of nutrient application shall correspond as closely as possible with plant nutrient uptake characteristics, cropping system limitations, weather and climatic conditions, and field accessibility.

Nutrients will not be applied to frozen, snow covered or saturated soil.

Additional Criteria Applicable to Utilizing Manure or Organic By-Products as a Plant Nutrient Source

Nutrient values of manure and organic by-products (excluding sewage sludge) shall be determined prior to land application based on laboratory analysis. The analysis shall include the results for moisture content, N, P, and K as a minimum. In the case of applying solid or semi-solid manure, the waste shall be sampled and analyzed at least once each year. The manure testing laboratory shall be certified through the Manure Analysis Proficiency Program administered by the Minnesota Department of Agriculture and Soil Science Society of America. A list of labs certified in this program can be found at the website below:

http://www.mda.state.mn.us/appd/manurelabs.htm?SEARCH.X=15\&SEARCH.Y=10

Historic laboratory analysis for solid and semi-solid manure values may be used in lieu of annual manure testing provided at least 3 years of manure testing history are available prior to application. The historic values must provide an accurate analysis of the material being applied. Manure analysis will be performed at least once every three years or sooner depending on federal, state or local laws. It is recommended that this be timed with soil testing procedures.

All waste water effluent shall be tested prior to land application. Refer to the Oklahoma NRCS Waste Utilization (633) standard, Oklahoma Technical Note Agronomy OK-17, job sheets JS 633 01 and JS 633 02 for guidance.

Preliminary planning decisions may be based on values found in the **Agricultural Waste Management Field Handbook, Chapter 4 - Agricultural Waste Characteristics**. Actual application rates will be adjusted accordingly based on the current manure analysis.

Plant nutrient removal rates can be found in **Table 7**. Crops not listed in **Table 7** may be found in the **Agricultural Waste Management Field Handbook, Chapter 6 – Role of Plants in Waste Management (Table 6-6).**

Do not apply manure or organic by-products in the following situations as described in the Published County Soil Survey or Section II of the NRCS Field Office Technical Guide:

- Liquid animal manure will not be land applied within 500 feet of the corner of an occupied

residence not owned or operated by the feeding operation.

- Liquid animal manure will not be land applied within 300 feet of an existing public or private drinking water well.
- To areas within 100 feet of a perennial stream, pond, well, or sinkhole, unless an established buffer strip is present. The width of the buffer strip will be used as a set back distance for application purposes. The buffer strip must meet the requirements for design and maintenance established in the appropriate NRCS buffer standard and specification.
- To areas within 50 feet of an intermittent stream unless an established buffer strip is present. The width of the buffer strip will be used as a set back distance for application purposes. The buffer strip must meet the requirements for design and maintenance established in the appropriate NRCS buffer standard and specification.
- To fields with > 15% slope.
- To soils less than 10 inches in depth to parent material.
- On soils that are frequently flooded.
- On soils that are frozen, snow covered, or water saturated (including periods of heavy rain when water ponding has occurred on the soil surface).
- On soils where the rock fragments in the surface layer are 3 to 10 inches in diameter and exceed 50% by weight.
- On soils where the rock fragments in the soil surface layer are > 10" in diameter and exceed 25% by weight.
- On soils where the rock fragments are > 10 inches in diameter which covers > 3% of the soil surface and the slope is > 8%. (Soil map unit name will include the description of Extremely Stoney, Extremely Bouldery, or Extremely Rubbly or Very Rubbly)
- On areas eroding at levels greater than the soil loss tolerance, "T", from wind or water erosion or active gullies unless following a conservation plan that will reduce erosion below "T". Use current Oklahoma NRCS soil loss prediction methods.
- On soils that are occasionally flooded. However, manure may be applied between June 20 and September 20 on soils classified as occasionally flooded. Manure may also be applied to soils classified as occasionally flooded between February 1 and April 20 if the area is established to cool season grasses 4 inches in height at the time of application. In no case will manure be applied when the soil is water saturated or when ponding has occurred on the soil surface after periods of heavy rain.

Organic Nutrient Application Rates
Timing and method of nutrient application shall correspond as closely as possible with plant nutrient uptake characteristics, cropping system limitations, weather and climatic conditions, and field accessibility. Nutrients materials will be applied uniformly to the area.

The application rate for waste water effluent applied with irrigation shall not exceed field capacity for the soil, create runoff and shall minimize ponding.

The following shall also be used when applying manure or organic by-products:

- **Nitrogen Application** – The amount of N applied from manure will not exceed the annual crop requirement for N. In some situations, additional N from inorganic/commercial sources may be required to supplement the organic sources. The N applied from inorganic/commercial sources shall match the crop requirement as closely as possible and shall not exceed 10% of the recommended inorganic/commercial fertilizer rate. Manure maybe applied to a legume crop at a rate equal to the estimated N removal in the harvested plant biomass.
- **Phosphorus Application** – The maximum planned rates of P application shall be determined using the Oklahoma Phosphorus Assessment Worksheet **(Tables 8 and 9).**

Field Risk Assessment
When applications of manure or other organic by-products are planned, a field-specific assessment of the potential for P transport from the site shall be completed. This assessment shall be done using the Oklahoma Phosphorus Assessment Worksheet **(Exhibit 2, Tables 8 and 9)**.

Heavy Metals Monitoring

When sewage sludge is applied, the accumulation of potential pollutants (including arsenic, cadmium, copper, lead, mercury, selenium, and zinc) in the soils shall be monitored in accordance with the US Code, Reference 40CFR, Parts 403 and 503, and/or any applicable state and local laws or regulations. The role of monitoring the application of sewage or municipal sludge in

Oklahoma is the responsibility of the Oklahoma Department of Environmental Quality (DEQ). Contact DEQ for information concerning the use of municipal sludge.

The Oklahoma Corporation Commission regulates land applications of waste material from oil and gas wells. Contact the Oklahoma Corporation Commission for information concerning regulations and permitting for land applications of these materials.

Additional Criteria to Minimize Agricultural Non-point Source Pollution of Surface and Ground Water Resources

For water bodies in watersheds identified by the Oklahoma Water Resources Board (OWRB) as Nutrient Limited Waters (NLW) in Appendix A and as designated in 785:45-5-29 of the Oklahoma's Water Quality Standards, an assessment shall be completed for the potential transport of P when manure or organic by-products are to be applied to a field. The Oklahoma Phosphorus Assessment Worksheet will be used to make the assessment.

Additional Criteria to Protect Air Quality by Reducing Nitrogen Emissions and the Formation of Atmosphere Particulates

When tillage can be performed, surface applications of manure and commercial fertilizer N formulations that are subject to volatilization on the soil surface (e.g. urea) shall be incorporated into the soil within 24 hours of application unless formulations with nitrification inhibitors, urease inhibitors, etc. are used that stabilize and slow the release of N.

When applying liquid forms of manure with irrigation equipment, select application conditions when there is high humidity, little/no wind, and/or other conditions that will minimize volatilization losses into the atmosphere.

Handle and apply poultry litter or other dry types of animal manures when weather conditions are calm and there is less potential for blowing and emission of particulates into the atmosphere.

Additional Criteria to Improve the Physical, Chemical, and Biological Condition of the Soil

Manure or organic by-products incorporated into the soil will improve soil structure.

Incorporate surface applied solid/semi-solid manure or other organic by-products, where tillage is possible, into the soil within 72 hours of application to minimize nutrient losses. Avoid applying materials that will not decompose in the soil.

When non-legume crop residues are returned to the soil, additional N may be needed to supplement the N being used by the soil microbes to breakdown residues. The additional N may be needed to avoid N deficiencies in the next crop.

Estimated N amounts needed per ton of crop residue are:

- Add 10 lbs. of N per ton of dry residue from non-legume crops.
- Add 5 lbs. of N per ton of non-legume green manure crop produced.

Most of the N legumes fix from the atmosphere is generally used for its own growth. Typical amounts of N remaining for the next crop are shown in **Table 6.**

High sodium concentrations in the soil will cause soil particles to disperse and deteriorate soil structure. The use of nutrient sources with high salt content and SAR will be minimized unless provisions are used to leach salts below the crop root zone.

CONSIDERATIONS

Avoid induced deficiencies of nutrients due to excessive levels of other nutrients.

Consider cover crops whenever possible to utilize and recycle residual nutrients.

Consider the following application methods, timing, and fertilizer materials that reduce the risk of nutrients being transported to ground and surface waters, or into the atmosphere by:

- using split applications of N to provide nutrients at times for maximum crop utilization,
- using Ramped Calibration Strips or N Rich Strips to determine mid-season (split) N application rates,
- using sensor technology (e.g. Green Seeker) to determine plant biomass production in conjunction with N rich strips or calibration strips,
- using application equipment with sensor technology (e.g. Green Seeker) to apply nutrients,
- using equipment with precision guided tools (e.g. GPS) for nutrient application,
- avoiding winter N application for spring seeded crops,
- banding P near the seed row,

- immediate incorporation of land applied manure or organic by-products,
- delaying field application of animal manures or other organic by-products if precipitation capable of producing runoff and erosion is forecast within 24 hours of the time of the planned application,
- using commercially available enhanced efficiency fertilizers or fertilizer additives (e.g. nitrification inhibitors, urease inhibitors and slow or controlled release fertilizers) that more closely match nutrient release and availability for plant uptake.

Consider the potential problems from odors associated with the land application of animal manure, especially when applied near or upwind of residences.

Consider the potential to affect National Register listed or eligible cultural resource sites.

Consider annual reviews to determine if changes in the nutrient budget are desirable (or needed) for the next planned crop.

On sites which have special environmental concerns, consider other sampling techniques. (For example: Soil profile sampling for N or surface sampling for P accumulation or pH changes.)

Consider ways to modify the chemistry of animal manure, including modification of the animal's diet to reduce the manure nutrient content, to enhance the producer's ability to manage manure effectively.

When applying manure with irrigation equipment, modification of the equipment can reduce the potential for volatilization of N from the time the manure leaves the application equipment until it reaches the surface of the soil (e.g. drop down tubes for center pivots). Nitrogen volatilization from manure in a surface irrigation system will be reduced when applied under a crop canopy.

Consider the combined effects of nutrient application methods and tillage operations on greenhouse gas emissions (e.g. nitrous oxide N_2O, carbon dioxide CO_2), and the potential for carbon sequestration.

PLANS AND SPECIFICATIONS

Plans and specifications shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose(s), using nutrients to achieve production goals and to prevent or minimize water quality impairment.

The following components shall be included in the nutrient management plan as applicable:

- aerial photograph or map and a soil map of the site,
- current and/or planned plant production sequence or crop rotation,
- results of soil, plant, water, manure or organic by-product sample analyses,
- realistic yield goals for the crops in the rotation,
- recommended nutrient rates, timing, form, and method of application and incorporation,
- location of designated sensitive areas or resources and the associated, nutrient management restriction,
- guidance for implementation, operation, maintenance, recordkeeping, and
- complete a nutrient budget for N, P, and K for the rotation or crop sequence.

If increases in soil phosphorus levels are expected, plans shall document:

- the soil phosphorus levels at which it may be desirable to convert to phosphorus based implementation,
- the relationship between soil phosphorus levels and potential for phosphorus transport from the field, and
- the potential for soil phosphorus drawdown from the production and harvesting of crops and
- the management activities or techniques used to reduce the potential for phosphorus loss.

When applicable, plans shall include other practices or management activities as determined by specific regulation, program requirements, or producer goals.

OPERATION AND MAINTENANCE

The owner/client is responsible for safe operation and maintenance of this practice including all equipment. The owner/client should consider addressing the following:

- Review plans periodically to determine if adjustments or modifications are needed. Changes in animal numbers, feed rations, crop rotations, storage facilities, and/or application timing or methods would be reasons for modifications to the nutrient management plan. Plans should be reviewed every three (3) years in conjunction

with the soil test cycle or with applicable federal, state or local laws.

- Calibration of application equipment to ensure uniform distribution of material at planned rates.
- Protect fertilizer, manure and/or organic by-products storage facilities from weather and accidental leakage or spillage.
- Documentation of the actual rate at which nutrients were applied. When the actual rates used differ from or exceed the recommended and planned rates, records will indicate the reasons for the differences.
- Records should be maintained to document plan implementation. As applicable, records should include:
  - soil test results and recommendations for nutrient application,
  - quantities, analyses and sources of nutrients applied,
  - dates and method of nutrient applications,
  - weather conditions and soil moisture at the time of application; time when a rainfall event or irrigation occurred after application of manure; time incorporation occurred after application of manure.
  - crops planted, planting and harvest dates, yields, and crop residues removed,
  - results of plant, water, manure, and organic by-product analyses, and
  - dates of review and person performing the review and recommendations that resulted from the review.

Records should be maintained for five (5) years; or for a period longer than five years if required by other Federal, state, or local ordinances, or program or contract requirements.

Workers shall avoid unnecessary exposure to hazardous chemical fertilizers and/or organic by-products. Protection should include the use of protective clothing when working with plant nutrients. Extra caution must be taken when handling ammonia sources of nutrients, or when dealing with organic wastes stored in unventilated enclosures.

Material generated by cleaning nutrient application equipment should be disposed of according to state and local guidelines and regulations. Excess material should be collected and stored or field applied in an appropriate manner.

Nutrient containers should be recycled in compliance with state and local guidelines or regulations.

REFERENCES

Follett, R.F. 2001. Nitrogen Transformation and Transport Processes. pp. 17-44, In R.F. Follett and J. Hatfield. (eds.). 2001. Nitrogen in the Environment; Sources, Problems, and Solutions. Elsevier Science Publishers. The Netherlands. 520 pp.

Sims, J.T. (ed.) 2005. Phosphorus: Agriculture and the Environment. Agron. Monogr. 46. ASA, CSSA, and SSSA, Madison, WI.

Stevenson, F.J. (ed.) 1982. Nitrogen in Agricultural Soils. Agron. Series 22. ASA, CSSA, and SSSA, Madison, WI.

SOIL TEST INTERPRETATIONS

Information contained in Tables 1, 2, 3, 4, and 5 comes directly from Oklahoma State Universities Extension Fact Sheet, *F-2225, OSU Soil Test Interpretations, and the Oklahoma USDA Cost-Share Lime and Fertilizer Recommendations (May 2004)*. The information contained in the tables should be used in conjunction with current soil test analysis to prepare nutrient budgets and to develop nutrient management plans for land users.

Nutrient requirements for crops not listed on the following tables should be referred to the OSU Extension Agent or Specialist.

Oklahoma State Extension Fact Sheets are available on-line at the following web site:

http://pods.dasnr.okstate.edu/docushare/dsweb/View/Collection-12

TABLE 1

Nitrogen Requirements

The nitrogen requirement is calculated by subtracting the soil test nitrogen value from the nitrogen required for a selected crop and yield goal.

	Wheat	Barley	Oat	Grain Sorghum		Corn		Cotton	
N Required lbs/ac	Yield Goal bu/ac			N Required lbs/ac	Yield Goal lbs/ac	N Required lbs/ac	Yield Goal bu/ac	N Required lbs/ac	Yield Goal bales/ac
30	15	20	25	**30**	2000	**40**	40	**30**	0.50
40	20	25	35	**40**	2500	**50**	50	**45**	0.75
60	30	35	55	**50**	3000	**60**	60	**60**	1.00
80	40	50	70	**70**	4000	**85**	85	**75**	1.25
100	50	60	90	**85**	4500	**110**	100	**90**	1.50
125	60	75	105	**100**	5000	**130**	120	**105**	1.75
155	70	90	125	**160**	7000	**190**	160	**120**	2.00
185	80	100	140	**195**	8000	**215**	180	**135**	2.25
240	100	125	175	**230**	9000	**240**	200	**150**	2.50
						300	250	**165**	3.00
						360	300	**180**	3.50

Cool Season Grasses (Fescue, Orchard,		Established Weeping Lovegrass		Established Old World Bluestem		Established Bermudagrass	
N Required lbs/ac	Yield Goal tons/ac	N Required lbs/ac	Yield Goal tons/ac	N Required lbs/ac	Yield Goal tons/ac	N Required lbs/ac	Yield Goal tons/ac
60	1	**35**	1	**35**	1	**50**	1
120	2	**70**	2	**70**	2	**100**	2
180	3	**110**	3	**110**	3	**150**	3
240	4	**160**	4	**150**	4	**200**	4
300	5	**220**	5	**200**	5	**260**	5
						320	6
						400	7

Alfalfa	Peanuts	Soybeans	Mungbeans, Cowpeas, Guar
10 to 20 lbs/ac for establishment. None needed for maintenance	**10 to 20 lbs/ac with P and K**	**10 to 20 lbs/ac with P and K**	**10 to 20 lbs/ac with P and K**

TABLE 1 (Cont.)

Nitrogen Requirements

The nitrogen requirement is calculated by subtracting the soil test nitrogen value from the nitrogen required for a selected crop and yield goal.

Canola		Virgin Native Hay Meadow		Small Grains for Grazing		Forage Sorghum or Corn Silage		
N Required lbs/ac	Yield Goal lbs/ac	N Required lbs/ac	Yield Goal tons/ac	N Required lbs/ac	Yield Goal tons/ac	N Required lbs/ac	Yield Goal	
							Silage tons/ac	Hay tons/ac
50	1000	**0**	1.0	**30**	0.5	**45**	5	2.5
75	1500	**50**	1.5	**60**	1.0	**90**	10	5.0
100	2000	**100**	1.6	**90**	1.5	**135**	15	7.5
125	2500			**120**	2.0	**185**	20	10.0
150	3000			**150**	2.5	**240**	25	12.5
175	3500			**180**	3.0	**300**	30	15.0

Nitrogen Recommendations for Establishing Grass

Soil Test N[1/]	Native Grass / Bluestem Establishments	All Other Grass Establishments
	N Required lbs/ac	
0	0	40
1	0	39
2	0	38
3	0	37
4	0	36
5	0	35
6	0	34
7	0	33
8	0	32
9	0	31
10	0	30
11	0	29
12	0	28
13	0	27
14	0	26
15	0	25
16	0	24
17	0	23
18	0	22
19	0	21
20	0	20
21+	0	0

[1/] **Nitrogen soil test values are only valid if test is within the last 60 days; therefore assume nitrogen soil test of zero (0) when old tests are used.**

Note: For recommendations on maintenance of grass stands for long-term deferment programs (e.g. CRP) follow the guidance in Tables 1, 2, 3 on Page 15 of this standard.

TABLE 2

Phosphorus Requirements

P Soil Test Index	Small Grains		Grain Sorghum		Corn		Cotton	
	P_2O_5 lbs/ac	Percent Sufficiency	P_2O_5 lbs/ac	Percent Sufficiency	P_2O_5 lbs/ac	Percent Sufficiency	P_2O_5 lbs/ac	Percent Sufficiency
0	80	25	60	40	80	30	75	55
10	60	45	50	60	60	60	60	70
20	40	80	40	80	40	80	45	85
40	20	90	20	95	20	95	30	95
65+	0	100	0	100	0	100	0	100

P Soil Test Index	Established Cool Season Grasses		Established Weeping Lovegrass		Established Old World Bluestem		Established Bermudagrass	
	P_2O_5 lbs/ac	Percent Sufficiency	P_2O_5 lbs/ac	Percent Sufficiency	P_2O_5 lbs/ac	Percent Sufficiency	P_2O_5 lbs/ac	Percent Sufficiency
0	80	30	60	50	60	50	75	50
10	60	50	50	70	40	70	60	65
20	40	70	40	85	30	85	40	80
40	20	95	20	95	20	95	20	95
65+	0	100	0	100	0	100	0	100

P Soil Test Index	Canola		Small Grains for Grazing		Legumes in Pasture		Virgin Native Hay Meadows	
	P_2O_5 lbs/ac	Percent Sufficiency	P_2O_5 lbs/ac	Percent Sufficiency	P_2O_5 lbs/ac	Percent Sufficiency	P_2O_5 lbs/ac	Percent Sufficiency
0	80	25	80	25	75	50	40	50
10	60	45	60	45	60	65	20	80
20	40	80	40	80	40	80	0	95
40	20	90	20	90	20	95	0	100
65+	0	100	0	100	0	100	0	100

P Soil Test Index	Alfalfa		Peanuts		Soybeans		Mungbean, Cowpeas, Guar	
	P_2O_5 lbs/ac	Percent Sufficiency	P_2O_5 lbs/ac	Percent Sufficiency	P_2O_5 lbs/ac	Percent Sufficiency	P_2O_5 lbs/ac	Percent Sufficiency
0	200	20	80	40	70	40	70	40
10	150	50	60	60	50	60	50	60
20	100	70	40	80	30	80	30	80
40	60	90	20	95	20	95	20	95
65+	0	100	0	100	0	100	0	100

TABLE 2 (Cont.)

Phosphorus Requirements

Phosphorus Recommendations for Establishing Grass

P Soil Test Index	Bermudagrass Establishments	Fescue and Cool Season Grass Establishments	Bluestem and Lovegrass Establishments	Native Grass Establishments
	P_2O_5 lbs/ac			
0	40	40	40	40
1	40	40	40	38
2	40	40	40	36
3	40	40	40	34
4	40	40	40	32
5	40	40	40	30
6	40	40	40	28
7	40	40	40	26
8	40	40	40	24
9	40	40	40	22
10	40	40	40	20
11-20	40	40	30	0
21-40	30	30	20	0
41-48	20	20	0	0
49+	0	0	0	0

Note: For recommendations on maintenance of grass stands for long-term deferment programs (e.g. CRP) follow the guidance in Tables 1, 2, 3 on Page 15 of this standard.

P Soil Test Index	Forage Sorghum or Corn Silage	
	P_2O_5 lbs/ac	Percent Sufficiency
0	100	30
10	75	60
20	45	80
40	25	95
65+	0	100

TABLE 3

Potassium Requirements

K Soil Test Index	Small Grains		Grain Sorghum		Corn		Cotton	
	K_2O lbs/ac	Percent Sufficiency	K_2O lbs/ac	Percent Sufficiency	K_2O lbs/ac	Percent Sufficiency	K_2O lbs/ac	Percent Sufficiency
0	60	50	100	40	120	40	110	40
75	50	70	75	65	80	60	80	60
125	40	80	50	80	60	75	60	75
200	20	95	30	95	40	90	40	90
250+	0	100	0	100	0	100	0	100

K Soil Test Index	Established Cool Season Grasses		Established Weeping Lovegrass		Established Old World Bluestem		Established Bermudagrass	
	K_2O lbs/ac	Percent Sufficiency	K_2O lbs/ac	Percent Sufficiency	K_2O lbs/ac	Percent Sufficiency	K_2O lbs/ac	Percent Sufficiency
0	70	60	80	40	80	40	140	40
75	60	70	60	60	60	60	80	60
125	50	80	40	80	40	80	50	75
200	30	95	20	95	20	95	30	90
250+	0	100	0	100	0	100	0	100

K Soil Test Index	Canola		Small Grains for Grazing		Legumes in Pasture		Virgin Native Hay Meadows	
	K_2O lbs/ac	Percent Sufficiency	K_2O lbs/ac	Percent Sufficiency	K_2O lbs/ac	Percent Sufficiency	K_2O lbs/ac	Percent Sufficiency
0	60	50	60	50	80	50	40	40
75	50	70	50	70	60	65	30	70
125	40	80	40	80	40	80	20	85
200	20	95	20	95	20	95	0	95
250+	0	100	0	100	0	100	0	100

Potassium Recommendations for Establishing Grass

Potassium (K) Soil Test Index	Bermudagrass Establishments	Fescue and Cool Season Grass Establishments	Bluestem and Lovegrass Establishments	Native Grass Establishments
	K_2O lbs/ac			
0-40	40	40	40	40
41-80	40	40	40	30
81-125	40	40	30	20
126-200	30	30	20	0
201-216	20	20	0	0
217+	0	0	0	0

Note: For recommendations on maintenance of grass stands for long-term deferment programs (e.g. CRP) follow the guidance in Tables 1, 2, 3 on Page 15 of this standard.

TABLE 3 (Cont.)

Potassium Requirements

K Soil Test Index	Alfalfa		Peanuts		Soybeans		Mungbeans, Cowpeas, Guar	
	K_2O lbs/ac	Percent Sufficiency	K_2O lbs/ac	Percent Sufficiency	K_2O lbs/ac	Percent Sufficiency	K_2O lbs/ac	Percent Sufficiency
0	280	20	80	40	100	40	80	50
75	210	50	60	60	70	60	60	60
125	140	70	40	75	60	75	45	80
200	80	90	30	90	40	90	30	90
250	40	100	0	100	0	100	0	100
350+	0	100	0	100	0	100	0	100

K Soil Test Index	Forage Sorghum or Corn Silage	
	K_2O lbs/ac	Percent Sufficiency
0	180	40
75	130	60
125	90	75
200	60	90
250+	0	100

Nutrient Requirements for Maintenance of Grasses in USDA Deferment Programs (e.g., CRP)

Table 1	
Soil Test N	Stand Maintenance of All Grasses
	N lbs/acre
0	40
1	39
2	38
3	37
4	36
5	35
6	34
7	33
8	32
9	31
10	30
11	29
12	28
13	27
14	26
15	25
16	24
17	23
18	22
19	21
20	20
21+	0

Table 2			
P Soil Test Index	Native Grass Stand Maintenance	Bluestem and Lovegrass Stand Maintenance	Stand Maintenance of All Other Grasses
	P_2O_5 lbs/acre		
0	40	40	40
1	38	40	40
2	36	40	40
3	34	40	40
4	32	40	40
5	30	40	40
6	28	40	40
7	26	40	40
8	24	40	40
9	22	40	40
10	20	40	40
11-20	0	30	40
21-40	0	20	30
41-48	0	0	20
49+	0	0	0

Table 3			
K Soil Test Index	Native Grass Stand Maintenance	Bluestem and Lovegrass Maintenance	Stand Maintenance for All Other Grasses
	K_2O lbs/ac		
0-40	40	40	40
41-80	30	40	40
81-125	20	30	40
126-200	0	20	30
201-216	0	0	20
217+	0	0	0

NRCS, OK
March 2007

TABLE 4
Liming Requirements

Lime required to raise the soil pH to 6.8 for all crops and 5.5 for continuous wheat or for grass establishment

Soil Buffer Index	All Crops, Established Grasses, or Legumes except Continuous Wheat **ECCE Lime (tons/ac)	*Continuous Wheat and New Seedlings of Grass (Establishment) **ECCE Lime (tons/ac)
6.0	5.2	1.4
6.1	4.7	1.2
6.2	4.2	1.0
6.3	3.7	0.9
6.4	3.1	0.8
6.5	2.5	0.6
6.6	1.9	*** 0.5
6.7	1.4	*** 0.5
6.8	1.2	*** 0.5
6.9	1.0	*** 0.5
7.0	0.7	*** 0.5
7.1	***0.5	*** 0.5
7.2	0.0	*** 0.5

*** Lime will be required for grass establishment when the soil test pH is <4.5 for fescue and lovegrass and <5.0 for all other grasses.**

**** Effective Calcium Carbonate Equivalent - Pure calcium carbonate ground fine enough to be 100% effective. The rate of aglime to apply can be determined from the ECCE requirement using the following formula: Tons of aglime/ac = Tons ECCE lime required / %ECCE x 100.**

***** Lime applications at or below 0.5 tons per acre are recommended, but not required due to economics.**

TABLE 5
Crop pH Preference *

Crop	Preferred pH Range
Cowpeas, Mungbeans, Corn, Guar, Oats, Rye, Sorghum, Sudan, Wheat	5.5 – 7.0
Cotton	5.7 – 7.0
Canola, Soybeans, Peanuts,	5.8 – 7.0
Barley	6.5 – 7.0
****Forages**	**Preferred pH Ranges**
Bluestem, Native Hay, Fescue, Weeping Lovegrass	4.5 – 7.0
Vetch, Crimson Clover, Orchardgrass, Ryegrass	5.5 – 7.0
Bermudagrass	5.7 – 7.0
Alsike, Red and White (ladino) Clovers, Arrowleaf Clover	6.0 – 7.0
Alfalfa, Sweet Clover	6.2 – 7.5

*** Most legumes will tolerate a pH 0.5 units less and 1.0 unit higher than indicated above, but production will be significantly reduced. Non-legumes tend to tolerate a pH 0.5 to 1.0 unit less (but not less than a pH of 4.0) and 1.0 to 2.0 units higher that indicated above.**

**** Lime will be required for grass establishment when the soil test pH is <4.5 for fescue and lovegrass and <5.0 for all other grasses.**

NRCS, OK
March 2007

TABLE 6

Nitrogen Credits

Average Nitrogen Remaining After Legume Crop

Legume	*Nitrogen remaining for next crop (Legume hayed or harvested)	**Green manure crop nitrogen remaining (Legume unharvested)
Alfalfa	80	200
Ladino Clover	60	180
Sweet Clover	60	120
Red Clover	40	115
White Clover	20	100
Soybeans	20	60
Cowpeas	30	90
Vetch	40	80
Lespedeza (annual)	20	85
Peas	40	70
Peanuts	20	40
Beans	20	40

*** These numbers are derived from crops that are harvested and have the remaining crop residues returned to the soil by tillage. (Reference - Oklahoma Soil Fertility Handbook, Sixth Edition (2006), pg. 18)**

**** A green manure crop is not harvested or grazed and is returned to the soil just prior to maturity. These numbers reflect the amount of nitrogen available for the next crop when the legume is used as a green manure crop. The numbers are adjusted to account for 30% nitrogen loss due to volatilization, leaching, and microbial action. (Reference – Soil Fertility and Fertilizers, Tidsdale and Nelson, pg. 128 and 566)**

TABLE 7
Crop Nutrient Removal *

% of Dry Material Harvested					
Crop	Unit	Weight/Unit	% N	% P	% K
Barley	grain	48 lbs/bu	1.82	0.34	0.43
	straw	72 lbs/bu	0.75	0.11	1.25
Corn	grain	56 lbs/bu	1.61	0.28	0.40
	stover	56 lbs/bu	1.11	0.20	1.34
Oats	grain	32 lbs/bu	1.95	0.34	0.49
	straw	64 lbs/bu	0.63	0.16	1.66
Rye	grain	56 lbs/bu	2.08	0.26	0.49
	straw	84 lbs/bu	0.50	0.12	0.69
Sorghum	grain	56 lbs/bu	1.67	0.36	0.42
	stover	56 lbs/bu	1.08	0.15	1.31
Soybeans	beans	60 lbs/bu	6.25	0.64	1.90
	stover	75 lbs/bu	2.25	0.22	1.04
Wheat	grain	60 lbs/bu	2.08	0.62	0.52
	straw	102 lbs/bu	0.67	0.07	0.97
Cotton	lint & seed	500 lbs/bale	2.67	0.58	0.83
	burs & stalks	3 lbs/lb of lint	1.75	0.22	0.83
% of Dry Material Harvested					
Forage Crop			% N	% P	% K
Alfalfa			2.25	0.22	1.87
Bermuda			1.88	0.19	1.40
Tall Fescue			1.97	0.20	2.00
Ryegrass			1.67	0.27	1.42
Wheatgrass			1.42	0.27	2.68
Dallisgrass			1.92	0.20	1.72
Native Hay			1.06	0.40	1.58
Clovers			2.00	0.22	1.66
Lespedeza			2.33	0.21	1.06

*** These crop nutrient removal figures come from the NRCS Agricultural Waste Management Field Handbook, Chapter 6, Role of Plants in Waste Management (Table 6-6). The handbook lists additional crops not listed above. These numbers represent average figures taken from multiple sources and are nutrients removed in the harvested portion of the crop. These figures can be used as guidance for waste management planning purposes. Actual waste application will be based on soil test.**

Example calculation to estimate nutrients removed

Wheat: Yield 40 bu/ac = 60 lbs/bu x 40 bu = 2400 lbs of grain

40 bu/ac x 102 lbs/bu straw = 4080 lbs/ac straw produced

1 ton/ac straw baled and removed from field = 1 ton/ac x 2000 lbs = 2000 lbs of straw/ac

Grain: 2400 lbs/ac x 0.0208 (%N/lb) = 49.92 lbs/ac Nitrogen in grain

2400 lbs/ac x 0.0062 (%P/lb) = 14.88 lbs/ac Phosphorus in grain

2400 lbs/ac x 0.0052 (%K/lb) = 12.48 lbs/ac Potassium in grain

Straw: 2000 lbs/ac x 0.0067 (%N lb) = 13.40 lbs/ac Nitrogen in straw

2000 lbs/ac x 0.0007 (%P lb) = 1.40 lbs/ac Phosphorus in straw

2000 lbs/ac x 0.0097 (%K/lb) = 19.40 lbs/ac Potassium in straw

Total Nutrient Removed = 63.32 lbs/ac N removed, 16.28 lbs/ac P removed, 31.88 lbs/ac K removed

NRCS, OK
March 2007

Exhibit 1 **Oklahoma Nutrient Budget Worksheet**

Landowner:				Field No.:		Acres:	
Crop Sequence/Rotation				Expected Yield			
Nutrient Content of Manure per ☐ Ton ☐ lbs./1000 gal.							
N Test	N Remaining	P_2O_5		K_2O			
Current Soil Test Levels							
N	P	K	pH	SOM%		EC	
Recommended Nutrients to Meet Expected Yield and Grass Establishment (See Tables in 590 Standard)							
N	N for Grass Est.	P_2O_5	K2O	Lime		Other	
Nutrient Sources							
Credits		N		P_2O_5		K_2O	
1. Nitrogen credits from previous legume crop							
2. Residual from long-term manure application							
3. Irrigation water							
4. Other (Atmosphere, etc.)		0					
5. Total Credits		0		0		0	
Applied Nutrients		N		P_2O_5		K_2O	
		Alt. 1	Alt. 2	Alt. 1	Alt. 2	Alt. 1	Alt. 2
6. Fertilizer	Starter						
	Other						
7. Manure or Organic by-products							
8. Total Applied Nutrients		0	0	0	0	0	0
9. Total Nutrients (add lines 5 and 8 plus N from Soil Test)		0	0	0	0	0	0
10. Recommended Nutrients		0	0	0	0	0	0
11. Nutrient Status (subtract line 10 from 9)		0	0	0	0	0	0

If line 11 is a negative number, this is the amount of additional nutrients needed to meet the crop recommendation.
If line 11 is a positive number, this is the amount by which the applied nutrients exceed the crop requirements.

Nutrient Management Decision - Including method, rate, form and timing of application.	Producer Selected Alternative:	

Ctrl + d clears worksheet

NRCS, OK
March 2007

Exhibit 2	OKLAHOMA PHOSPHORUS ASSESSMENT WORKSHEET				
Client Name:		Field(s):		Date:	
Planner:		Location:		Crop:	
Nutrient Limited Watershed (yes/no):				Ctrl + C clears worksheet	
Site Characteristics					
Soil Test P Index Mehlich III (lbs./ac)					
Application Method	Surface applied and incorporated within 7 days or injected 2" below the surface	Surface applied or incorporated more than 7 days after application	Surface applied on frozen, snow covered, or water saturated ground		
Land Slope %	0 - 8 %	8.1 - 15 %	> 15.1 %		
Transport Characteristics					
Erosion Rate Greater Than "T"	No	Yes			
Flooding Frequency	None	Occasionally	Frequently		
Distance of Manure Application to Perennial Stream, Pond, Well, Sinkhole, or Residence	> 100 ft. to perennial stream, pond, well, sinkhole or a Buffer Strip is Established >300 ft. to Drinking Water Well (Liquid Manure Application) >500 ft. to an Occupied Residence (Liquid Manure Application)	<100 ft. to a perennial stream, pond, well, or sinkhole <300 ft. to Drinking Water Well (Liquid Manure Application) <500 ft. to an Occupied Residence (Liquid Manure Application)			
Distance of Manure Application to Intermittent Stream	> 50 ft. or a Buffer Strip is Established	< 50 ft.			
Depth of Soil	> 20.1 in.	10.1 - 20 in.	0 - 10 in.		
Rock Fragments in Soil Surface 3" to 10 " in diameter and exceed 50% by weight or > 10" in diameter and exceed 25% by weight	No	Yes			
Rocks > 10" in diameter which cover > 3% of the Soil Surface	No	Yes			
Non - Nutrient Limited Watershed – Manure Application Rates					
Nutrient Limited Watershed – Manure Application Rates					

Table 8
Annual Manure Application Rates for Non-Nutrient Limited Waters

Rating	Soil Test P Index	0 – 8% Slope	8 to 15% Slope	0 to 15% Slope
		Soil > 20" Deep	Soil > 20" Deep	Soil 10" to 20" Deep
*Low	0 – 65	Full Rate	Full Rate Split Application	Half Rate
*Moderate	66 – 250	Full Rate	Half Rate	Half Rate
*High	251 – 400	Half Rate	Half Rate	Half Rate
*Very High	> 400	Plant Removal[1]	Plant Removal[1]	Plant Removal[1]
*Severe	*	No Application	No Application	No Application

Rating	Soil Test P Index	Rocks >10" in diameter which cover >3% of the soils surface and <8% slope
*Low	0 – 65	Half Rate
*Moderate	66 – 250	Half Rate
*High	251 – 400	Half Rate
*Very High	> 400	Plant Removal[1]
*Severe	*	No Application

[1] Note – It may not be feasible to calibrate equipment and make manure applications at the Plant Removal rate.

Table 9
Annual Manure Application Rates for Nutrient Limited Waters

Rating	Soil Test P Index	0 – 8% Slope	8 to 15% Slope	0 to 15% Slope
		Soil > 20" Deep	Soil > 20" Deep	Soil 10" to 20" Deep
*Low	0 – 65	Full Rate	Full Rate Split Application	Half Rate
*Moderate	66 – 120	Full Rate	Half Rate	Half Rate
*High	121 – 300	Half Rate	Half Rate	Half Rate
*Severe	> 300	No Application	No Application	No Application

Rating	Soil Test P Index	Rocks >10" in diameter which cover >3% of the soils surface and <8% slope
*Low	0 – 65	Half Rate
*Moderate	66 – 120	Half Rate
*High	121 – 300	Half Rate
*Severe	> 300	No Application

* See Severe Rating - No Application listed below. Check for specific site characteristics which may deem the field inadequate for manure application from the list below.

Annual manure application rates are listed and explained below.

Manure Application Rates

Full Rate – Not to exceed the Nitrogen requirement of the crop and the following P_2O_5 rates:

1. 200 lbs P_2O_5 per acre when surface applied.
2. 300 lbs P_2O_5 per acre when application is by sprinkler irrigation and managed to prevent runoff from the field.
3. 400 lbs P_2O_5 per acre if injected below the soil surface or surface applied and incorporated within 7 days.

Half Rate – Not to exceed the Nitrogen requirement of the crop and the following P_2O_5 rates:

1. 100 lbs P_2O_5 per acre when surface applied.
2. 150 lbs P_2O_5 per acre when application is by sprinkler irrigation and managed to prevent runoff from the field.
3. 200 lbs P_2O_5 per acre if injected below the soil surface or surface applied and incorporated within 7 days.

Split Application – Not to exceed the Nitrogen requirement of the crop

Application will be no more than ½ the allowed P_2O_5 rate per application at least 30 days apart.

Severe Rating - No Manure Application

Do not apply manure or organic by-products in the following situations. Reference the Published County Soil Survey or Section II of the NRCS Field Office Technical Guide.

- Liquid animal manure will not be land applied within 500 feet of the corner of an occupied residence not owned or operated by the feeding operation.
- Liquid animal manure will not be applied within 300 feet of an existing public or private drinking water well.
- To areas within 100 feet of a perennial stream, pond, well, or sinkhole, unless an established buffer is present. The width of the buffer will be used as a set back distance for application purposes. The buffer must meet the requirements for design and maintenance established in the NRCS buffer standard and specification.
- To areas within 50 feet of an intermittent stream unless an established buffer is present. The width of the buffer will be used as a set back distance for application purposes. The buffer must meet the requirements for design and maintenance established in the NRCS buffer standard and specification.
- To fields with > 15% slope.
- To soils with less than 10 inches in depth to parent material.
- On soils that are frequently flooded.
- On soils that are frozen, snow covered, or water saturated (including periods of heavy rain when water ponding has occurred on the soil surface).
- On soils where the rock fragments in the surface layer are 3 to 10 inches in diameter and exceed 50% by weight.
- On soils where the rock fragments in the soil surface layer are > 10" in diameter and exceed 25% by weight.
- On soils where the rock fragments are > 10 inches in diameter which covers > 3% of the soil surface and the slope is > 8%.
- On areas eroding at levels greater than the soil loss tolerance, "T", from wind or water erosion or active gullies unless following a conservation plan that will reduce erosion below "T". Use current Oklahoma NRCS erosion prediction methods.
- On soils that are occasionally flooded. However, waste may be applied between June 20 and September 20 on soils classified as occasionally flooded. Manure may also be applied to soils classified as occasionally flooded between February 1 and April 20 if the area is established to cool season grasses 4 inches in height at the time of application. In no case will manure be applied when the soil is water saturated or when ponding has occurred on the soil surface after periods of heavy rain.